

Simulations of Laser Imprint on Nova, Vulcan, and NIF*

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In direct drive ICF, nonuniformities in laser illumination seed ripples at the ablation front in a process called "imprint". These nonuniformities grow during the capsule implosion and can penetrate the capsule shell, impede ignition, or degrade burn. We have simulated imprint for several recent experiments performed on the Nova laser at LLNL and on the Vulcan laser at Rutherford Lab. One set of Nova experiments measure imprint for planar CH₂ foils probed with a thermal (U) x-ray backlighter at ~1.5 keV. These foils were illuminated with 0.53 or 0.35 μm light using random phase plates, with or without SSD smoothing. Another Nova experiment employs a Y XUV laser to probe imprint of 0.35 μm light on 3 μm thick Si foils. The Vulcan experiments measure imprint of 0.53 μm light on 2 μm thick Al foils probed with a Ge XUV laser, for variety of beam smoothing conditions. Most of these experiment use laser intensities similar to the early part of an ignition capsule pulse shape, $I \cong 10^{13} \text{ W/cm}^2$. We will present comparisons of these imprint measurements with simulations. We have also simulated imprint upon National Ignition Facility (NIF) direct drive ignition capsules. We will show simulated imprint amplitudes and resulting shell modulation through the course of the implosion. SSD with 0.5 THz bandwidth is predicted to give an imprint modulation amplitude comparable to an intrinsic surface finish of ~40 nm rms. Imprinted modulation is treated as an equivalent surface finish for the purpose of addressing the modulation growth through the implosion and stagnation of the capsule shell. This growth has been examined both by the Haan model, where linear growth factors as a function of spherical harmonic mode number are obtained from an analytic dispersion relation, and by direct numerical simulation using two-dimensional multimode LASNEX calculations. This analysis may be used to set beam smoothing requirements for the laser.

* Work performed under the auspices of the U. S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.